



## Department of Energy

Washington, DC 20585

August 9, 2007

Dr. James Siegrist, Director  
Lawrence Berkeley National Laboratory  
Physics Division  
One Cyclotron Road  
Berkeley, CA 94720

Dear Dr. Siegrist:

This letter reports the findings and recommendations from our annual program review conducted March 20–22, 2007. While it is based predominantly on the letters submitted by the reviewers who visited the lab, it is also based on information from other dedicated reviews that we conduct, such as the LHC Software and Computing Review, and input from Office of High Energy Physics program managers who interact with the lab.

I would like to extend my deep gratitude to you and your staff for the effort that went into the review and your hospitality. Our visits to Berkeley are always interesting and productive. I do regret that I was unable to attend the review this year, and hope to make it up with a personal dedicated trip in the near future.

As I believe you are aware, we discovered that most of the reviewers found the presentations of the lab's budget to be confusing. One of the key factors in a merit review is the cost efficiency of the research performed. Is the government receiving good value for its expenditures? It can be complex to explain this, especially when some of the reviewers come from other types of institutions like universities or foreign laboratories that have different financial systems. Despite this complexity the issue must be addressed successfully.

## Experimental Program

### ATLAS

The laboratory's choices for contributions to ATLAS, the vertex detector and core software, are well chosen for impact and matched to the laboratory's strengths. The work in these areas has been done well. The commissioning of the pixel system requires significant manpower, but the lab has addressed that concern.

The LBNL ATLAS group presented a credible plan for physics leadership in ATLAS. This included the early development of the physics case and now features work on the data quality tasks. Beate Heinemann is a well respected physicist and her addition to the group should also increase the likelihood of the laboratory achieving physics leadership in ATLAS.



It was not clear from the review that LBNL would have a large contingent of students on ATLAS. The quality of the Berkeley graduate program combined with the resources of the lab should be able to support a substantial group of excellent students.

## **CDF and Babar**

This year once again the reviewers are concerned by the dramatic reduction of effort on CDF in favor of ATLAS. The concern is always expressed in terms of the loss of opportunity to exploit the physics of Run II. The reduction of the laboratory's Babar effort is more apparent, but this was also a point of contention among those who felt Run II is more compelling.

However, we believe the lab's plan to deliver on its commitments to ATLAS is the correct course and that reversing that course will do more harm than good. This review confirms that the laboratory is delivering high quality work on ATLAS with great potential. My only concern is that the laboratory maintains its excellent scientific reputation, but I believe the decisions of how to do that are best left to laboratory management.

## **Cosmology and Particle-Astrophysics**

The laboratory has been the leader among the DOE national labs in successfully exploiting the link between particle physics and astrophysics. The work of George Smoot on the Cosmic Microwave Background was one of the first forays of DOE labs into astrophysics and it has now been recognized by a Nobel Prize. The past discovery of the accelerating expansion of the universe by the Supernova Cosmology Project is of similar importance.

The laboratory currently has several efforts in dark energy including, the Supernova Cosmology Project (SCP), Nearby Supernova Factory (SNF), and the Supernova Acceleration Probe (SNAP), a concept for the DOE/NASA Joint Dark Energy Mission. In addition, there are small efforts in Cosmic Microwave Background and Astrophysics theory. Each group reports independently to the Physics Division Director and competes for LDRD funds. It is not clear to us how priorities are being effectively set amongst the efforts.

SCP is producing excellent scientific results with the Supernova Legacy Survey that are critical to understanding the systematic uncertainties of using Type Ia supernova to constrain cosmological parameters. The Hubble Space Telescope Type Ia program is a spin-off of SCP and has yielded more than 10 supernova with redshift greater than 1.

SNF is studying very low redshift Type Ia supernova. The Dark Energy Task Force has called for a sample of about 500 such supernova to be studied, and SNF has a goal of collecting about 300 Type Ia supernova in the red shift range of 0.03-0.08 and measuring their spectra. At last year's review it was already clear that SNF was not on track to achieve its goals, and was discussed in last year's letter. Now the number of supernova found per month is up from 1-3 per month to 6-8 per month, but only 100-120 good Type

1a supernova are now expected by the end of 2008. SNF is largely considered to be disappointing by the community.

SNAP design R&D is mature and well developed. The major question is whether JDEM will be chosen by the Beyond Einstein Program Assessment Committee as the first NASA Beyond Einstein Mission to be funded. This should be resolved by the end of the year. If JDEM is chosen, the path forward is relatively clear. If JDEM is not chosen, then a new plan will need to be developed.

There is a new proposal to study dark energy, called BOSS, which will conduct a baryon acoustic oscillations study using the Sloan Digital Sky Survey telescope. This experiment would be a Stage III dark energy project that could precede SNAP. We received some very good feedback on this project from the review. The LBNL effort, led by Schlegel and Roe, will be in charge of the upgrade to the spectroscopic system. This is a major upgrade requiring some innovative technology that the Lab is well suited to develop. However, we will await a formal proposal from the lab before making any decisions concerning this project.

The lab should look at its overall cosmology program and attempt to optimize it. There are successes like SCP, problems like SNF, large efforts with an uncertain path forward like SNAP, and smaller new initiatives like BOSS. This is becoming quite an extensive set of efforts which needs to be actively managed to maximize productivity. Attempts have been made to do that, but it does not appear to be successful. The Dark Energy Planning Committee was formed to coordinate the dark energy programs in the Physics Division, but evidently it has not met since the November 2006 review.

## Daya Bay

The CD-1 review of the Daya Bay project went well, and LBNL is to be credited for their work in preparing the project for the review. LBNL has played critical roles in engineering, project management, and fostering the collaboration, especially developing relationships the Chinese members of the collaboration. These roles utilize the strengths of the laboratory. However, the reviewers were very concerned by the size of the lab scientific effort on the project. As one put it:

*Calling it sub-critical would not be an overstatement, and in particular I worry that so little staff effort collaborating with the required engineering effort will simply not be able to provide adequate guidance and supervision.*

With the current scientific effort, the laboratory is making a valuable contribution to the project, but a stronger scientific effort could make LBNL's contribution a key to the success of the experiment.

## ILC Detector R&D

The reviewers were split on the relevance of the ILC detector R&D. Some felt that it was good work being conducted at an appropriate level for a project with a long period to the decision to proceed; others felt it was premature to be doing it now. The ILC detector R&D is clearly less well-developed than the accelerator R&D program, and OHEP is

working on a management structure for the detector effort. Until we have a structure in place it is hard for us to give solid guidance to the lab on how to proceed. The reviewers did have one suggestion that you should carefully consider. There may be strong synergies in the ILC detector R&D and the LHC upgrade R&D. The details of the work may be quite different but the expertise needed to carry out both programs should be quite similar.

## **Theory Program**

There are now only three senior staff members in the laboratory theory group, Chanowitz, Ligeti, and Bauer. They work in flavor physics, collider physics, and electroweak precision measurements. All are active and productive. The reviewers endorsed the need for a new staff hire in the theory group since the theory group is currently understaffed. At the same time, the reviewers are comfortable with some delay in the hiring of a new group member until attrition dictates the need for additional staff.

A significant strength of the group appears to be their mentoring of postdoctoral researchers in collaboration with the theory group in the University of California-Berkeley Physics Department, which is a very strong group. Almost all theory postdocs have gone onto tenure-track faculty positions in high energy physics. Managing the balance of the theory activities at the lab and on campus is very important.

## **Accelerator Physics Program**

### **L'Oasis**

Wim Leemans's presentation was excellent, and the rest of the staff would do well to emulate him. He gave a clear explanation of the current status of his program with full details on staffing. He directly addressed last year's comments from the committee, and he gave a well reasoned and documented plan for the work he would like to do in the next few years.

The l'Oasis work was well received. Work is going on in injection, beam diagnostics, and staging of the acceleration. The group does experiments demonstrating the laser acceleration of beams and can explain its results through analytic calculations and computer simulations. The reviewers commented on the excellent training provided to students and postdocs by the l'Oasis group.

The BELLA proposal to use a Petawatt laser to demonstrate  $> 10$  GeV of acceleration in a plasma now appears to be well enough developed for serious consideration, but it is expensive enough that a dedicated peer review is needed before acting. We have begun our planning for such a review, and we will work out the details with you soon.

## **Superconducting Magnets**

The superconducting magnet program focuses on the development of forefront magnet technology using  $\text{Nb}_3\text{Sn}$  superconductor. The goal is to develop a large aperture quadrupole for the LHC luminosity upgrade and later a high field dipole that could be used in an LHC energy upgrade with funding from both the LHC Accelerator R&D program and the "core program." The group has expertise, steady funding, and most of the needed infrastructure to achieve its goals. The group attracts a good number of students and visitors. The need for an improved testing capability was acknowledged by the reviewers.

## **Center for Beam Physics**

The consultant's evaluation of the Center for Beam Physics was not as strong as for the other accelerator programs at the lab. Only the beam instrumentation work was uniformly praised. The e-cloud simulations were recognized as important, but experimental measurements on suppression techniques are also needed. The evaluation of the muon collider/neutrino factory effort was mixed. Work is proceeding slowly due to limited funds, but it is being done well. What key contribution that the lab is making was not clear to the reviewers. Similarly, the role of the laboratory in the ILC engineering design effort was not clearly presented, even though the lab was very visible in the preparation of the ILC Reference Design Report.

The center is not making the impact that I'Oasis and superconducting magnets are making. A national lab is more than a collection of talented investigators. It would be wise for the lab to consider directing more of the resources supplied by HEP to the high impact efforts to ensure their continued success, while exploring new ways of getting a maximum impact from CBP.

## **Particle Data Group and Quarknet**

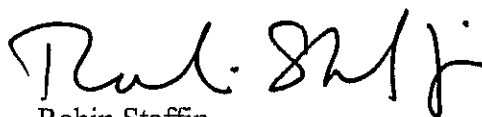
The work of the Particle Data Group is a valuable service to the community and merits continued support. The Review of Particle Physics has continued to evolve with the field, but a question was raised about the wisdom of the PDG developing a new review of cosmology. Such a new initiative could use more careful thought before proceeding.

The education outreach efforts are also excellent. Michael Barnett has developed a strong program, and it could be even stronger if more of the laboratory staff contributed.

## Conclusion

The science done at Berkeley continues to be excellent, but there are management issues that need to be addressed. I ask that you supply a written response to this letter within 60 days.

Sincerely,

A handwritten signature in black ink, appearing to read "Robin Staffin". The signature is fluid and cursive, with a large initial "R" and a stylized "S".

Robin Staffin  
Associate Director  
Office of High Energy Physics